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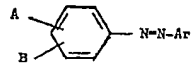
(19)

(54) ANTIMICROBIC AZO DYES AND A METHOD FOR PRODUCING THEREOF

(71) We, MOSKOVSKY ORDENA TRUDOVOGO KRASNOGO ZNAMENI TEXTILNY INSTITUT an enterprise organised and existing under the laws of the Union of Soviet Socialist Republics (USSR), of 26 Konskaya ulitsa, Moscow, USSR, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to new antimicrobic azo dyes and a method of producing them.

According to the present invention there are provided antimicrobial azo dyes represented by the general formula

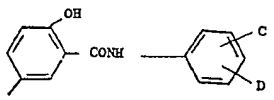


wherein

A is H or OCH_3;

B is H, SO_3Na or $SO_2CH_2CH_2OSO_3Na$;

Ar is



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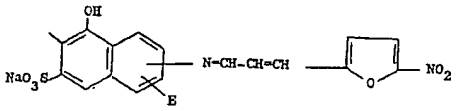


wherein

C and D which are the same or different are H or Hal, and

E is H or SO_3Na.

The dyes according to the present invention are water-soluble powders, the colour ranging from yellow to red and brown.

[*Price 33p*]

The fabrics dyed with the aforesaid dyes possess antimicrobic properties with respect to bacteria as well as to fungi. The bacterial contamination of fabrics subjected to dyeing with antimicrobic dyes drops by 80 to 100 percent as compared with undyed fabrics. The fungicidal properties of samples dyed with said dyes are characterised in that almost in all cases microscopic examination shows the growth of spores of fungi to be absent completely.

The antimicrobic treatment of textile fabrics results in a marked decrease or complete absence of microbic contamination of manufactured articles, prevents fungi development on the clothing and human integument and protects the fabrics from rot and destruction by mould fungi.

Antimicrobic textile fabrics are extremely useful for the manufacture of clothing and underwear to be used where infection hazards exist or where sanitary facilities are inadequate for meeting personal hygiene requirements, for example in surgery wards or in wards housing patients suffering from infectious diseases, maternity hospitals and during travel. The antimicrobic fabrics find wide use in the shoemaking industry as a means of controlling diverse foot skin lesions.

In addition to the above spheres of application, antimicrobic fibre finds wide use in technology and engineering, for instance in the manufacture of felt blankets employed in the cellulose and paper industry.

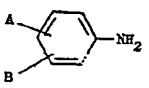
Antimicrobic fibre is used for air sterilisation in the pharmaceutical industry in the manufacture of antibiotics, in food preservation, and for filtering water contaminated by pathogenic bacteria in water basins.

The textile fabrics treated with the antimicrobic azo dyes according to the present invention do not produce a toxic or irritating effect on a person wearing the treated fabric.

Antimicrobic effect remains effective during the entire service life of an article treated with the dyes of the present invention and the eqect is not imparted by frequent washing. The antimicrobic dyes of the present invention are heat and light resistant and do not impart any odour to the manufactured articles.

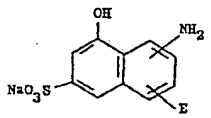
The most potent antimicrobic azo dyes of the present invention are sodium 4 - (3^1 - phenylcarbamoyl - 4^1 - hydroxyphenylazo) - benzenesulphonate, sodium 4 - [3^1 - (3^{11} - chlorophenylcarbamoyl) - 4^1 - hydroxyphenylazo] - benzenesulphonate, sodium 4 - hydroxy - 3 - (3^1 - chlorophenylcarbamoyl) - 1 - [5^{11} - (2^{111} - sulphatoethylsulphonyl) - 2^{11} - methoxyphenylazo] - benzene, sodium 4 - [3^1 - (2^{11}, 5^{11} - dichlorophenylcarbamoyl) - 4^1 - hydroxyphenylazo] - benzenesulphonate, disodium 1 - hydroxy - 7 - [3^1 - (5^{11} - nitrofur - 2^{11} - yl) - 2^1 - propenylideneamino] - 2 - [5^{111} - (2^{1111} sulphatoethylsulphonyl - 2^{111} - methoxyphenylazo] - naphthalene - 3 - sulphonate, and disodium 1 - hydroxy - 8 - [3^1 - (5^{11} - nitrofur - 2^{11} - yl) - 2^1 - propenylideneamino] - 2 - phenylazonaphthalene - 3,6 - disulphonate.

Still further according to the present invention there is provided a method of preparing the aforesaid dyes comprising effecting coupling between a compound of the general formula Ar—H wherein Ar is as defined above and a diazonium compound derived from a compound of the formula



wherein A and B are as defined above in an aqueous alkaline medium and at a temperature within the range from 0 to 5°C.

The substituted naphthalene compound Ar—H may be prepared by reacting a compound of the general formula



wherein E is as defined above with 3 - (5^1 - nitrofur - 2^1 - yl - acrolein in an aqueous alcoholic medium and at a temperature of up to 60°C and allowing the reaction mixture to stand at room temperature for a period from 2 to 12 hours.

The following Examples are given by way of illustration of the present invention.

Example 1

2g. of 1 - hydroxy - 7 - aminonaphthalene - sulfonic acid and 2g. of anhydrous sodium acetate were dissolved under elevated temperature in 30 ml. of 50% alcohol and then mixed with a solution of 3.3g. of 3 - (5^1 - nitrofur - 2^1 - yl)acrolein in 30 ml. of 95% ethyl alcohol, the latter solution being prepared at a temperature of 60°C. The mixture was allowed to stand for 10 to 12 hours. The precipitate of 1 - hydroxy - 7 - [3^1 - (5^{11} - nitrofur - 2^{11} - yl) - 2^1 - propenylideneamino] naphthalene - 3 - sulphonic acid was filtered and dried at a temperature of 50°C. The yield of the product was 92 weight percent of the calculated amount.

2g. of the product obtained were dissolved in water with the addition of 0.52g. of soda ash, cooled to a temperature of 0°C., to which solution was gradually added over a 30 min. period, the diazonium compound prepared by diazotising sodium 5 - (2^1 - sulphatoethylsulphonyl) - 2 - methoxyaniline with sodium nitrite in a sulphuric acid medium.

The reaction mixture was stirred for one hour and allowed to stand for 3 hours. The precipitated dye was filtered off and dried at a temperature of 50°C. The product thus obtained is disodium 1 - hydroxy - 7 - (3^1 - (5^{11} - nitrofur - 2^{11} - yl) - 2^1 - propenylideneamino] - 2 - 5^{111} - (2^{1111} - sulphatoethylsulphonyl) - 2^{111} - methoxyphenylazo] - naphthalene - 3 - sulphonate. The yield is 3.1g. or 83 weight percent of the calculated amount. The dyestuff produced is a dark-red powder, the aqueous solution thereof having a red colour.

Analysis %
Calculated for $C_{25}H_{30}N_4O_{14}S_3Na$, N=7.43
Found N=7.50; 7.19.

The dyestuff synthesized as described above, was used to dye fabrics in order to determine the biological activity of the dyed fabric spécimens. The antimicrobic activity was evaluated by the following procedure.

Generally, the antimicrobic activity of a material containing bactericidal compounds is determined by using microorganisms possessing different biological properties and exhibiting different resistances to physical and chemical factors.

The test-microbes conventionally used are Staphylococcus aureus as a representative of the Gram-positive group of microorganisms, and bacteria coli commune, representing the Gram-negative group.

Since the resistance of different strains of one and the same species of microorganisms to bactericides varies within a rather wide range, use is made of strains exhibiting resistance that meets the standard requirements. These are Staphylococcus aureus strain 906, which resists for 20—25 minutes exposure to a phenol solution (dilution 1:70) and are not killed when heated to a temperature of 59—60°C. for 30 minutes, and Bacteriat coli commune strain 1257, showing a 15—20

minute resistance to a phenol solution (dilution 1:90) and thermal stability for 20—35 minutes at 59°C.

Dyed fabric specimens are contaminated by applying thereon droplets of the bacteria culture obtained by diluting a 24-hour agar culture (count, 2 billion bacteria as checked against an optical turbidity standard) to the requisite concentration, bacteria suspension preparation and dilution involving the use of sterilised tap water.

The samples of the fabrics tested, measuring 4×4 cm., are placed in sterile Petri dishes and the bacteria suspension prepared as described above is atomised so as to infect said dyed fabric specimens with the microorganisms to the extent of 10^3 bacteria per 1 cm^2.

To estimate the number of bacteria after a 60 minute contact, the test samples are placed in test tubes each containing beads and 20 ml of physiological saline. The test tubes are shaken for 10 minutes in a shaking machine, followed by using 1 ml. portions of the wash solution to inoculate meat-infusion agar in 2 or 3 Petri dishes so as to obtain the submerged culture.

All the tests involve keeping the samples in a thermostat for 24 to 28 hours at a temperature of 37°C whereupon the colonies thus grown are counted. All the tests are repeated two or three times under similar test conditions.

Bacterial concentration diminution is expressed as percentage of the bacterial concentration of a reference specimen.

The bacterial concentration in the specimens of the fabrics dye with the dye of Example 1 was found to decrease by 98 percent in the case of Staphylococcus aureus and by 92 percent for Bacteria coli commune.

Example 2

2g. of 1 - hydroxy - 8 - aminonaphthalene - 3,6 - disulphonic acid and 2g. anhydrous sodium acetate were dissolved in 25 ml. of 50% alcohol, and mixed with 3.3g. of 2 - (5^1 - nitrofur - 2^1 - yl)acrolein dissolved at a temperature of 60°C in 30 ml of 95% ethanol. The mixture was allowed to stand for 6—8 hours. The precipitate comprising 1 - hydroxy - 8(3^1 - (5^{11} - nitrofur - 2^{11} - yl - 2^1 - propenylideneamino)naphthalene - 3,6 - disulphonic acid was filtered off and dried at a temperature of 30 to 40°C., to yield 2.8g. of the coupling component or 90 weight percent of the calculated amount.

2g. of the product obtained was dissolved in water with the addition of 0.65g. of soda ash, cooled to a temperature of 0°C., to which solution at a temperature of 0 to 5°C was gradually added, over a 20 minute period, phenyldiazonium chloride prepared by diazotizing aniline with sodium nitrite in a hydrochloric acid medium.

The reaction mixture was stirred for a period of 1 to 2 hours and allowed to stand for 5 to 6 hours. The precipitated dye was filtered off and dried at a temperature of 50°C. The product thus obtained is disodium 1 - hydroxy - 8 - [3^1 - (5^{11} - nitrofur - 2^{11} - yl) - 2^1 - propenylideneamino] - 2 - phenylazonaphthalene - 3,6 - disulphonate, the yield being 1.9g. of 80% of the calculated amount.

The dyestuff is recrystallised from water. The dyestuff produced is a brown powder, the aqueous solution thereof having a dark-red colour.

Analysis %
Calculated for $C_{23}H_{14}N_4O_{10}S_2Na_2$ N=9.09
Found N=8.45
M.W. 616

A sample of fabric dyed with the dyestuff obtained was subjected to the antibacterial activity test according to the procedure outlined in Example 1.

The bacterial concentration in the fabric speciments dyed with the dye of Example 2 decreased in the case of Staphylococcus aureus and Bacteria coli commune by 95 percent and 89 percent, respectively.

Example 3

0.85g. of Salicyanilide was dissolved in 10 ml. of water containing 0.16g. of sodium hydroxide, to which mixture was added 0.84g. of soda ash, and while stirring, a suspension of 4 - sulphonatobenzenediazonium obtained from sodium 4 - aminobenzenesulphonate in hydrochloric acid medium at a temperature of 5 to 10°C., was gradually added. The medium was weakly alkaline. The stirring was continued for 2 to 3 hours. The residue was filtered off and dried. The product thus obtained is sodium 4 - (3^1 - phenylcarbamoyl - 4 - hydroxyphenylazo)benzenesulphonate, the yield being 1.5g. or 90 weight percent of the calculated amount. The dyestuff is recrystallised from water.

Analysis %
Calculated for $C_{19}H_{14}N_3O_5SNa$ N=10.02
Found N=9.00; 9.14
M.W. 419.

The thus synthesised dye is a yellow powder which imparts to fabrics a yellow colour. The dyed fabric specimens are a yellow colour. A sample of fabric dyed with the dyestuff was subjected to the antibacterial activity test according to the procedure outlined in Example 1.

The bacterial concentration in the fabric specimens dyed with the dye of Example 3 decreased in the case of Staphylococcus aureus and Bacteria coli commune by 80 percent and 78 percent, respectively.

The mould resistance test was carried out

by the standard procedures by the dish method and the IEC (International Electrotechnical Committee).

The dish method is selective and consists in that the dyed fabric specimens infected with a definite fungus strain are placed in a nutrient medium and kept in a thermostat for 14 days. To evaluate the fungus resistance use is made of the following three-mark system:

1.—a protective zone has been formed around the sample;

2.—no protective zone, and the fungi on the sample do not develop;

(2—)—in screening tests, single grown spores are observed on the sample;

3.—the sample shows a strong growth and sporulation of the mould fungi.

In tests according to the IEC procedure, the samples of fabric are treated with a suspension of 7 species of mould fungi and placed in a stationary chamber, wherein they are kept at a relative humidity of 98 to 100 percent.

Fungus resistance assessment is carried out in compliance with the following five-mark system:

0—complete absence of fungi spores under a microscope;
1—single germinating spores;
2—a considerable number of germinated spores;
3—development of spore-bearing mycelium on the fabric seen with the naked eye;
4—abundant development of spore-bearing mycelium.

Of practical importance are samples of fabrics graded from 0 to 2 marks inclusive.

The fabric specimens dyed with the colour of Example 3 were found to display fungus resistance of 2 - (the dish method) and 0 (the IEC method).

Example 4

2.47g. of 3 - chloroanilide of salicyclic acid was dissolved in 15—20 ml. of water, to which 0.48 g. of pure NaOH was added. Next 2.5g. of soda ash was introduced into the solution, followed by gradually adding to the stirred solution (temperature, 5—10° C) a suspension of 4 -sulfonatobenzenediazonium prepared by diazotising sodium 4 - aminobenzenesulphonate in sulphuric acid. The reaction mixture was alkaline to Brilliant Yellow indicator paper. Stirring was continued for a period of 2 to 3 hours, whereupon the precipitate was filtered off and dried. There was obtained 3.6g. (90% of the calculated amount) of sodium 4 - [3^1 - (3^{11} - chlorophenylcarbamoyl) - 4^1 - hydroxyphenylazo] - benzenesulphonate. The dye was recrystallised from water.

Analysis %
Calculated for $C_{19}H_{13}N_3O_3SClNa$; N=9.25
Found N=8.57; 8.55
M.W. 453

The thus synthesised dye is a yellow powder and fabric specimens dyed therewith are yellow in colour.

The procedure described in Example 1 was used for assessing the antimicrobial activity of fabric specimens dyed with the dye of Example 4, and the bacterial concentration was found to decrease in the case of Staphylococcus aureus and Bacteria coli commune by 88% and 84%, respectively.

The fungus resistance of the dyed fabric specimens evaluated in compliance with the procedure described in Example 3 was found to be 2 - (the dish method) and 0 (the IEC method).

Example 5

2.82 g. of 2,5 - dichloroanilide of salicylic acid was dissolved in 10—15 ml. of water containing 0.48 g. of sodium hydroxide, followed by adding to the solution 1g. of soda ash and gradually introducing into the stirred solution at room temperature a suspension of 4 - sulphonatobenzenediazonium prepared by diazotising sodium 4 - aminobenzenesulphonate in sulphuric acid at room temperature. Stirring was continued for 1—2 hours, and the precipitate was filtered off and dried. There was obtained 3.5 g (80% of the calculated amount) of sodium 4 - [3^1 - (2^{11}, 5^{11} - dichlorophenylcarbamoyl) - 4^1 - hydroxyphenylazo] benzenesulphonate.

Analysis %
Calculated for $C_{19}H_{12}N_3O_5Cl_2SNa$; N=8.60
Found N=8.99; 9.42.

The thus synthesised dye is a red-brown powder which imparts an orange colour to fabric specimens dyed therewith.

Fabric specimens dyed with the dye of Example 5 were subjected to the antimicrobial activity test and the fungus resistance test in compliance with the procedures described in Example 1 and Example 3, respectively. The bacterial concentration was found to decrease by 99.2% in the case of Staphylococcus aureus and by 100% as regards Bacteria coli commune, while the fungus resistance was estimated as —2(the dish method) and 0 (the IEC method).

Example 6

2.47 g. of 3 - chloroanilide of salicyclic acid was dissolved in 15—20 ml of water containing 0.48 g. of sodium hydroxide, followed by adding to the solution 1.5 g. of soda ash and introducing gradually into the stirred solution a suspension of 5 - (2^1 - sulphato - ethylsulphonyl) - 2 - methoxy - benzenediazonium obtained by diazotising

sodium 5 - (2^1 - sulphatoethylsulphonyl) - 2 - methoxyaniline with sodium nitrite in a sulphuric acid medium.

The reaction mixture was stirred for 2—3 hours at a temperature of from 0 to 5°C, followed by filtering off and drying (at 40°C) the precipitated dye. There was obtained 4.8 g. (82% of the calculated amount) of sodium 4 - hydroxy - 3 - (3^1 - chlorophenylcarbamoyl) - 1 - - [5^{11} - (2^{111} - sulphatoethylsulphonyl) - 2^{11} - methoxyphenylazo] - benzene.

Analysis %

Calculated for $C_{22}H_{19}O_9N_3S_2ClNa$; N=7.1

Found N=7.81; 7.96.

M.W.=591.5.

The thus synthesised dye is a yellow powder which imparts yellow colour to fabric specimens dyed therewith.

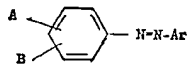
Fabric specimens dyed with the dye of Example 6 were subjected to the antimicrobial activity test and the fungus resistance test in compliance with the procedures disclosed in Example 1 and Example 3, respectively.

The concentration of Staphylococcus aureus was found to decrease by 90%, and that of Bacteria coli commune also by 90%.

The fungus resistance was estimated as −2 (the dish method) and 0 (the IEC method).

WHAT WE CLAIM IS:—

1. Antimicrobial azo dyes represented by the general formula

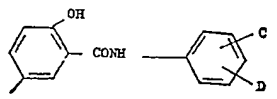


wherein

A is H or OCH_3;

B is H, SO_3Na or $SO_2CH_2CH_2OSO_3Na$;

Ar is



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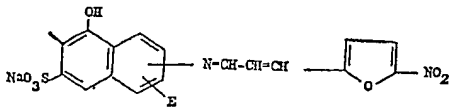


wherein

C and D which are the same or different and H or Hal, and

—E is H or SO_3Na.

2. Sodium 4 - (3 - phenylcarbamoyl - 4^1 - hydroxyphenylazo) - benzenesulphonate.

3. Sodium 4 - [3^1 - (3^{11} - chlorophenylcarbamoyl) - 4^1 - hydroxyphenylazo] - benzenesulphonate.

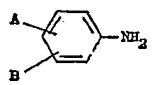
4. Sodium 4 - hydroxy - 3 - (3^1 - chlorophenylcarbamoyl) - 1 - [5^{11} - (2^{111} - sulphatoethylsulphonyl) - 2^{11} - methoxyphenylazo] - benzene.

5. Sodium 4 - [3^1 - (2^{11}, 5^{11} - dichlorophenylcarbamoyl) - 4^1 - hydroxyphenylazo] - benzene sulphonate.

6. Disodium 1 - hydroxy - 7 - [3^1 - (5^{11} - nitrofur - 2^{11} - yl) - 2^1 - propenylideneamino] - 2 - [5^{111} - (2^{1111} - sulphatoethylsulphonyl) - 2^{111} - methoxyphenylazo] - naphthalene - 3 - sulphonate.

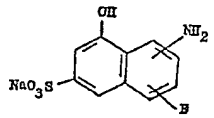
7. Disodium 1 - hydroxy - 8 - [3^1 - (5^{11} - nitrofur - 2^{11} - yl) - 2^1 - propenylideneamino] - 2 - phenylazonaphthalene - 3,6 - disulphonate.

8. A method of preparing the antimicrobial azo dyes claimed in claim 1, comprising effecting coupling between a compound of the general formula Ar—H where Ar is as defined in claim 1 and a diazonium compound derived from a compound of the formula



wherein A and B are as defined in claim 1 in an aqueous alkaline medium and at a temperature within the range from 0 to 5°C.

9. A method as claimed in claim 8, wherein the substituted naphthalene compound Ar—H is prepared by reacting a compound of the general formula



wherein E is as defined in claim 1 with 3 - (5^1 - nitrofur - 2^1 - yl) - acrolein in an aqueous alcoholic medium and at a temperature of up to 60°C, allowing the reaction mixture to stand at room temperature for a period of from 2 to 12 hours.

10. A method of preparing the antimicrobial azo dyes claimed in claim 1, according to claim 8, and substantially as hereinbefore described with reference to any one of the Examples.

11. An antimicrobial azo dye whenever prepared by the method claimed in any one of claims 8 to 10.

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